

# **Indian Point Radioactive Liquid Effluents**

**Dave Lochbaum  
March 12, 2022**

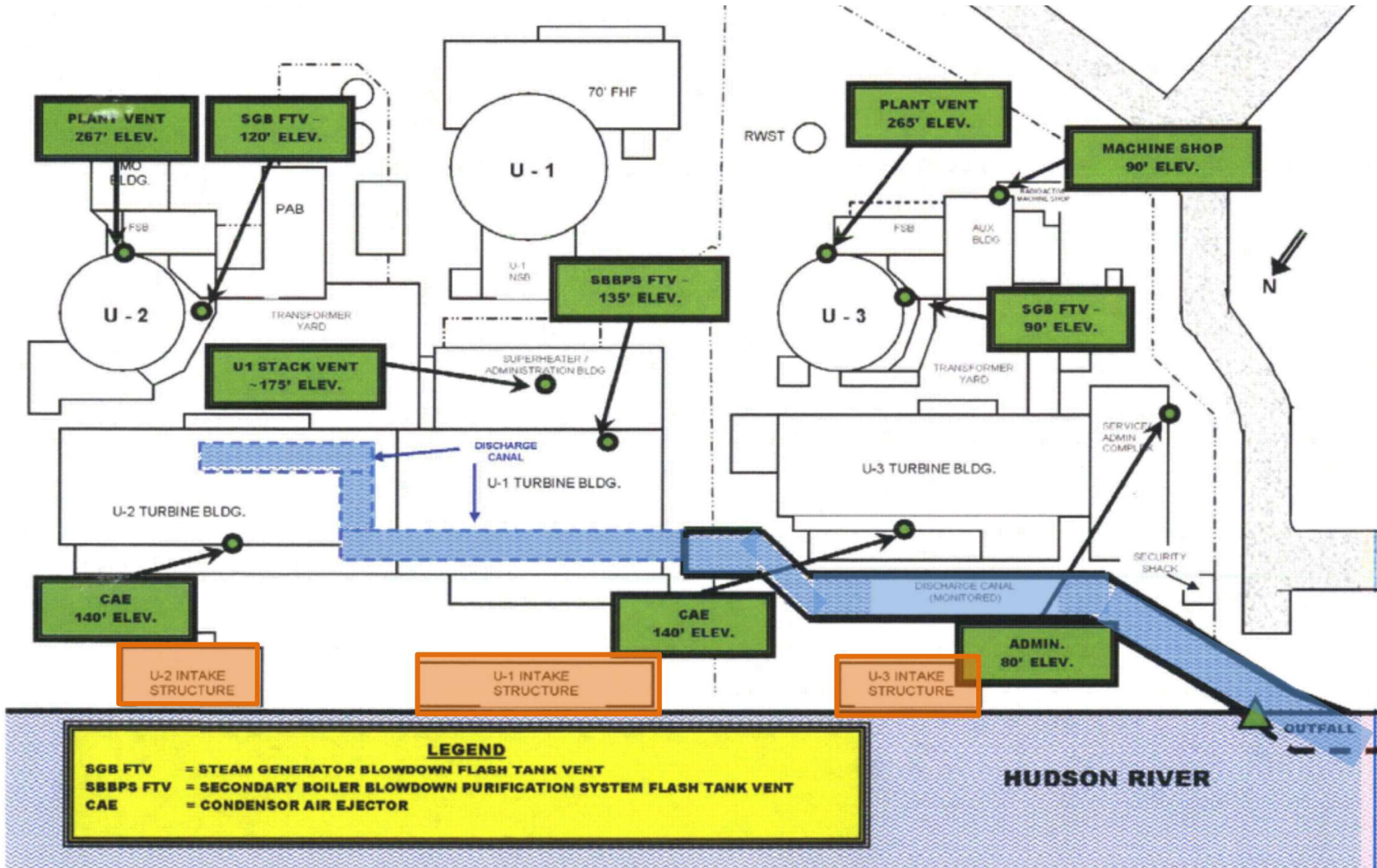
	Processed Waste (LW & NCD)	Unprocessed Waste (SGBD, SFDS, USFD)	Volume of Dilution Water
	Gallons	Gallons	Gallons
2005	3,756,640	<b>89,557,020</b>	734,420,400,000
2006	3,492,460	56,217,504	737,062,200,000
2007	2,861,069	50,194,200	737,062,200,000
2008	3,471,325	52,180,834	750,271,200,000
2009	2,768,606	53,813,466	726,495,000,000
2010	2,977,309	47,446,728	715,927,800,000
2011	<b>4,874,121</b>	51,726,444	739,704,000,000
2012	3,479,251	50,088,528	750,271,200,000
2013	3,769,849	65,965,746	742,345,800,000
2014	2,922,359	49,480,914	739,704,000,000
2015	3,693,236	53,760,630	752,913,000,000
2016	3,310,175	39,014,102	710,644,200,000
2017	2,483,292	48,899,718	776,689,200,000
2018	3,920,431	52,624,656	797,823,600,000
2019	2,818,801	56,587,356	<b>805,749,000,000</b>

**Annual discharges of water from Indian Point Units 1, 2 and 3 into the Hudson River. Maximum volumes of each category shown in enlarged boldface type.**

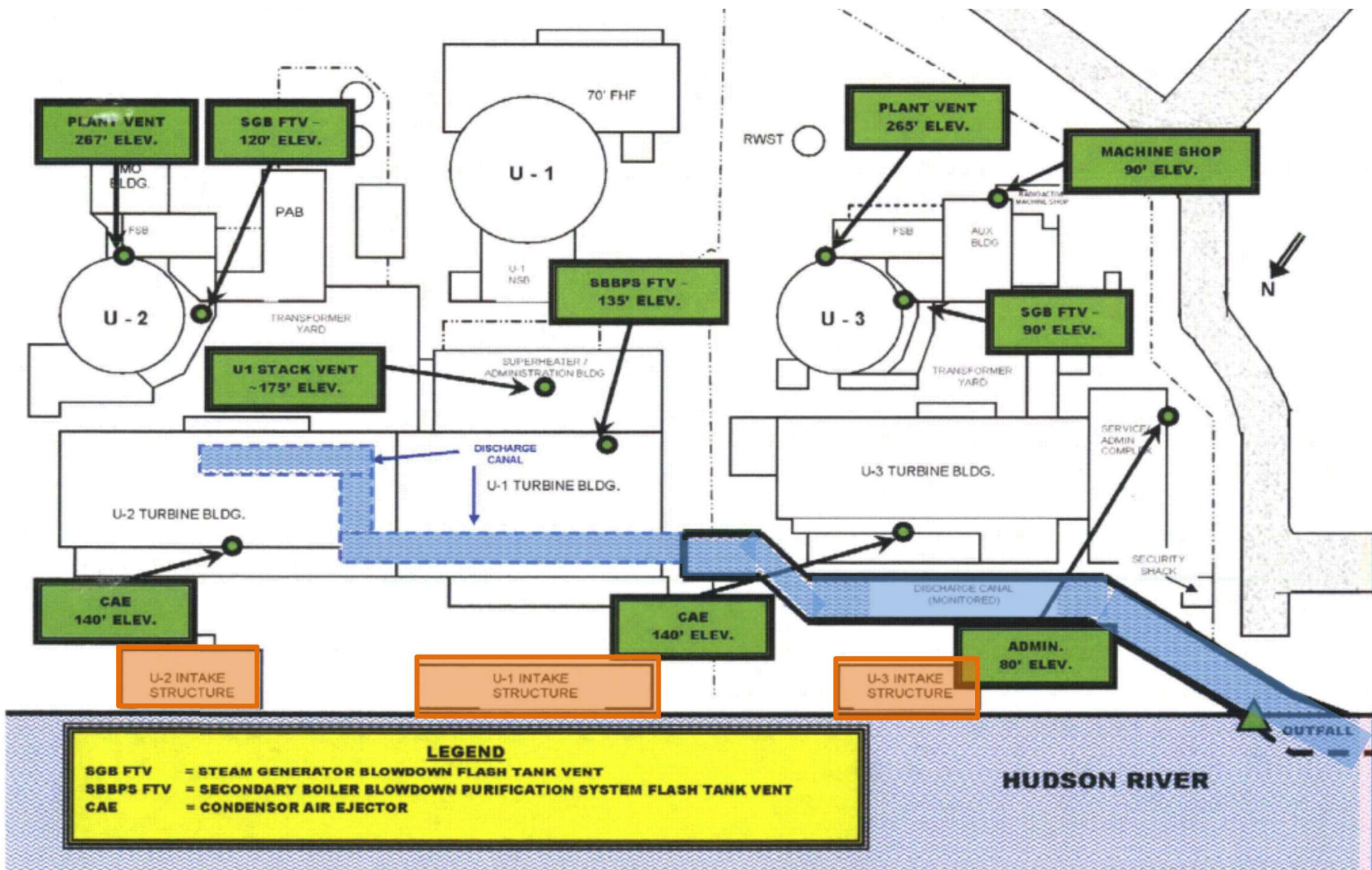
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**Dilution water is clean, uncontaminated water into which the processed and unprocessed waste streams are routed before discharge to the river.**

**Dilution water enters via the **intake structures**, flows through the condensers and other heat exchangers before flowing via the **discharge canal** to the river.**

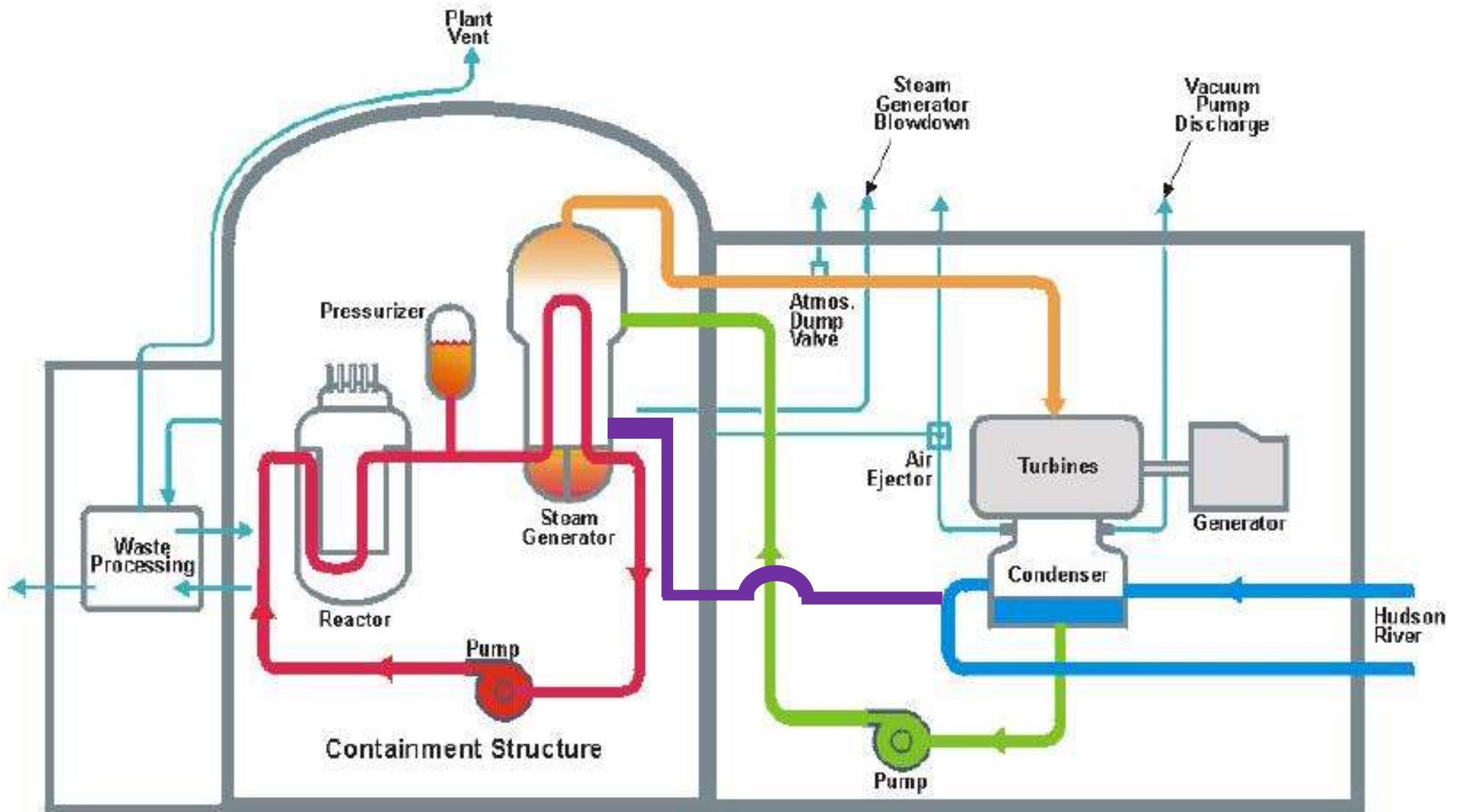


**The main condensers and other exchangers are designed such that if a tube leaks, river water leaks in rather than contaminated water leaking out**

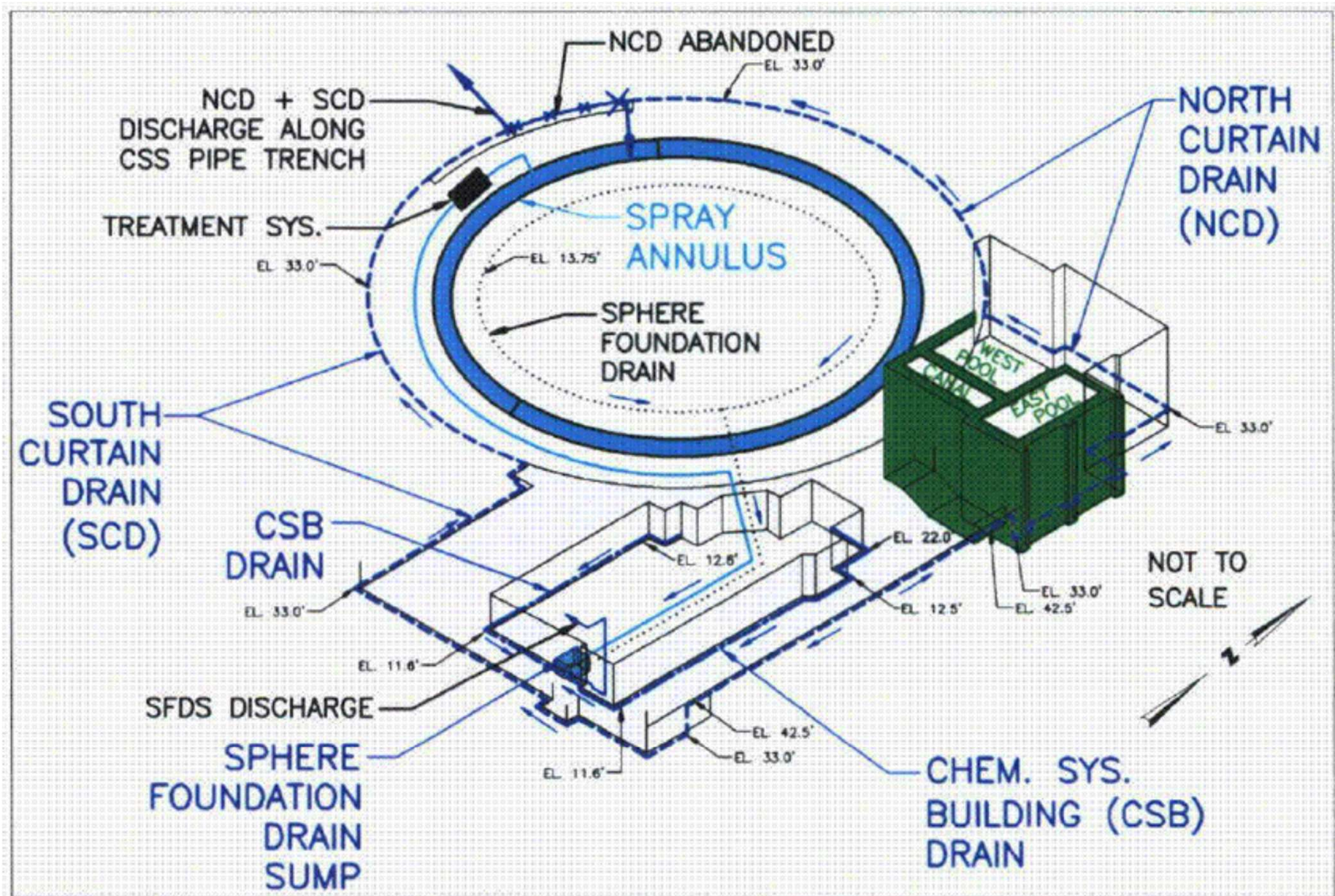


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**Unprocessed waste water includes the Steam Generator Blowdown (SGBD) flow and the Sphere Foundation Drain Sump (SFDS) flow. While unprocessed, these flows are monitored and controlled to avoid excessive releases.**



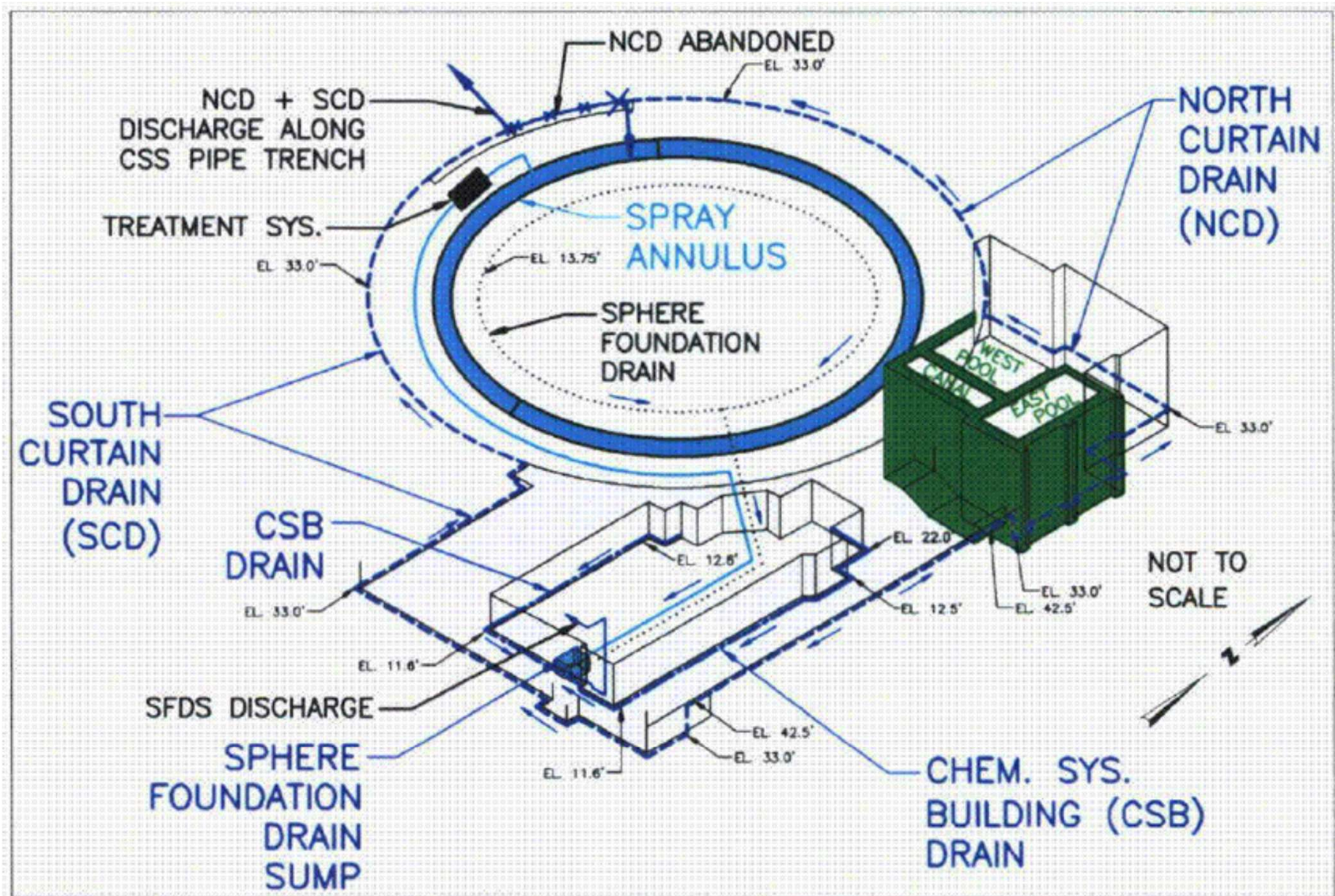
The magenta line represents the Steam Generator Blowdown line. Some of the water from the outside of the many tubes inside the steam generators is discharged to control the water chemistry of the secondary loop. Unless a tube leaks contamination from the primary loop, this flow is clean water.



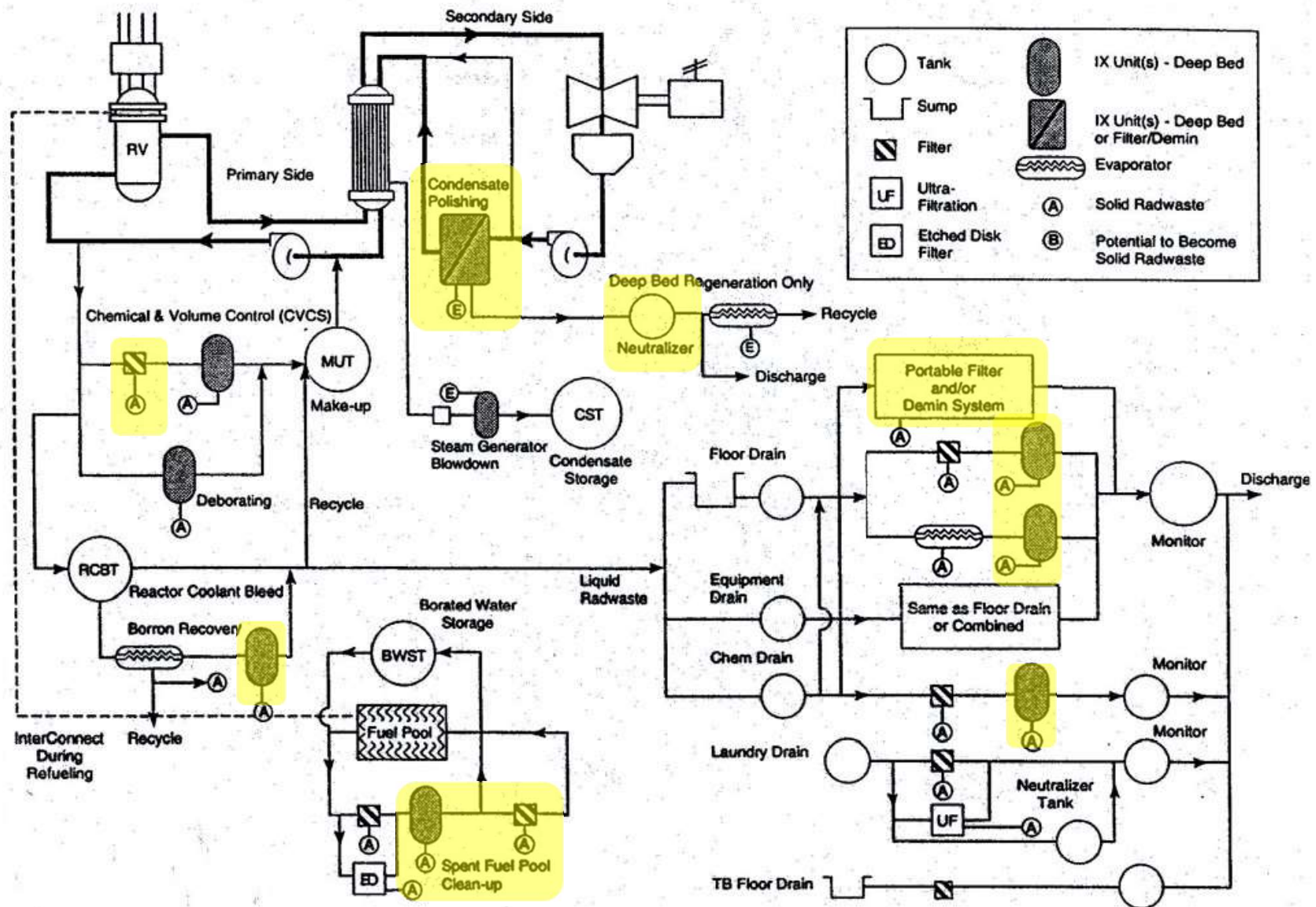
**The Sphere Foundation Drain Sump flow includes water spilled in or leaking into the Unit 1 containment.**

	Processed Waste (LW & NCD) Gallons	Unprocessed Waste (SGBD, SFDS, USFD) Gallons	Volume of Dilution Water Gallons
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**The processed waste water constitutes the lowest volume but highest radioactive content of the discharges to the Hudson River. It consists of water released from the Liquid Waste (LW) systems and the water released from the North Curtain Drain (NCD) system.**



**Due to leakage of water from the Unit 1 spent fuel pool (shown in green), the North Curtain Drain has contained radioactively contaminated water.**



The Liquid Waste systems use filters to remove particles from water and polishers (demineralizers) to remove dissolved materials. Note that the discharge pathways have Monitors to check the radiation levels of the effluent flows.



Facility: Indian Point Energy Center

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YEAR: 2019

Indian Point Units 1, 2 and 3

Docket Nos.: 50-3, 50-247, & 50-286

Entergy Nuclear Operations, Inc. (Entergy)

Annual Radioactive Effluent Release Report

**2.0 Batch Releases:**

1. Airborne

Table 2.5-1 - Airborne Batch Releases

Unit 1 and 2 Airborne Releases	Qtr 1	Qtr 2	Qtr 3	Qtr 4	2019
Number of Batch Releases	51	52	51	60	215
Total Time Period (min)	2800	2750	2470	3300	11320
Maximum Time Period (min)	85	101	85	173	173
Average Time Period (min)	54.9	52.8	48.4	55	52.8
Minimum Time Period (min)	20	3	20	12	3

Unit 3 Airborne Releases	Qtr 1	Qtr 2	Qtr 3	Qtr 4	2019
Number of Batch Releases	27	25	17	14	83
Total Time Period (min)	2040	2400	2480	1850	8770
Maximum Time Period (min)	168	193	542	223	542
Average Time Period (min)	75.5	95.9	146	132	106
Minimum Time Period (min)	5	4	1	1	1

2. Liquid

Table 2.5-2 – Liquid Batch Releases

Unit 1 and 2 Liquid Releases	Qtr 1	Qtr 2	Qtr 3	Qtr 4	2019
Number of Batch Releases	5	13	2	0	20
Total Time Period (min)	481	1200	139	0	1820
Maximum Time Period (min)	114	99	69.5	0	114
Average Time Period (min)	96.2	92.3	96	0	90
Minimum Time Period (min)	90	65	43	0	43

Unit 3 Liquid Releases	Qtr 1	Qtr 2	Qtr 3	Qtr 4	2019
Number of Batch Releases	40	29	28	5	102
Total Time Period (min)	4470	3220	3100	555	11345
Maximum Time Period (min)	119	124	117	115	124
Average Time Period (min)	112	111	111	111	111
Minimum Time Period (min)	107	105	107	108	105

Federal regulations require all liquid and gaseous releases of radioactive materials to be monitored and the totals reported to the NRC annually.

NRC inspectors periodically audit the monitoring and reporting processes.

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Entergy Nuclear Operations, Inc. (Entergy)

Annual Radioactive Effluent Release Report

Table 6-1 Summation of Dose Assessments

Year: 2019		Total Body	Max Organ
40 CFR 190 limit ==>	IPEC	25 mrem	75 mrem
Routine Airborne Effluents <sup>1</sup>	Units 1 and 2	1.46E-03	1.46E-03
Routine Liquid Effluents	Units 1 and 2	5.08E-04	7.65E-04
Liquid Releases of C <sup>14</sup>	Units 1 and 2	1.17E-03	5.83E-03
Airborne Releases of C <sup>14</sup>	Units 1 and 2	6.51E-02	3.26E-01
Routine Airborne Effluents <sup>1</sup>	Unit 3	3.14E-03	3.14E-03
Routine Liquid Effluents	Unit 3	8.12E-05	2.79E-04
Liquid Releases of C <sup>14</sup>	Unit 3	1.17E-03	5.83E-03
Airborne Releases of C <sup>14</sup>	Unit 3	6.18E-02	3.10E-01
Ground Water & Storm Drain Totals	IPEC <sup>2</sup>	5.69E-05	2.30E-04
Direct Shine from areas such as dry cask storage, radwaste storage, SG Mausoleum, etc.	IPEC <sup>3</sup>	3.00E-01	3.00E-01
Indian Point Energy Center Total Dose, per 40 CFR 190	IPEC	4.34E-01	9.54E-01

Note 1: Routine airborne dose in this table is conservatively represented as a sum of Iodine, Particulate, and Tritium dose (excluding C-14, in mrem) with a mrem term added from noble gas gamma air energy (mrad, expressed as mrem). This 'addition' does not represent a real dose and is listed here solely to help demonstrate compliance with 40CFR190. (Doses by type of release and comparison to the specific limits of 10CFR50 Appendix I are summarized on the following pages.)

Note 2: Groundwater curie and dose calculations are provided in Attachment 2.

Note 3: 40CFR190 requires the reporting of total dose, including that of direct shine. Direct shine dose from sources other than dry cask are indistinguishable from background. Direct shine dose is determined from TLDs near the dry cask area and site boundary, compared with REMP TLDs and historical values, and corrected with occupancy factors to determine a bounding, worst case assessment of direct shine dose to a real individual. Details of each year's dose evaluation are available on site.

Federal regulations further require assessment of the radiation dose to the public from the released radioactive materials.

Federal limits on radiation dose to the public

In 2019, radiation total body doses to the public from releases to the water were 0.005508 millirem from Units 1 and 2 and 0.0000812 millirem from Unit 3 -- well below the federal limit of 25 millirem

	Fission and Activation Products	Tritium	Dissolved and Entained Gases	Gross Alpha	Total Curies
	Curies	Curies	Curies	Curies	
2005	0.075	1272.000	0.075	0.000	1272.150
2006	0.059	1558.000	<b>0.382</b>	0.000	1558.441
2007	0.054	1468.000	0.040	0.000	1468.094
2008	0.069	667.021	0.038	0.000	667.127
2009	0.063	1859.000	0.009	0.000	1859.071
2010	0.067	1390.000	0.001	0.000	1390.067
2011	0.056	1907.000	0.025	0.000	1907.081
2012	0.047	1989.000	0.002	0.000	1989.050
2013	0.076	<b>2045.000</b>	0.003	0.000	<b>2045.079</b>
2014	0.040	640.000	0.000	0.000	640.041
2015	0.077	1972.000	0.012	0.000	1972.089
2016	<b>0.138</b>	1083.000	0.000	0.000	1083.138
2017	0.080	1422.000	0.004	0.000	1422.084
2018	0.090	1358.000	0.001	0.000	1358.090
2019	0.039	832.000	0.001	0.000	832.040

**This table shows the amounts of radioactivity in water discharged to the Hudson River. Tritium forms the primary constituent of radioactivity releases. Tritium is a radioactive isotope of hydrogen. When tritium forms part of a water molecule, it is virtually impossible to remove from water by filters, polishers, and demineralizers. Maximum amounts of each category shown in enlarged boldface type.**

	Total Whole Body Dose	Total Body Dose Limit (40 CFR 190)	Fraction of Limit
	millrem	millrem	
2005	0.001256	25	0.0050%
2006	0.001007	25	0.0040%
2007	0.000855	25	0.0034%
2008	0.000767	25	0.0031%
2009	0.001149	25	0.0046%
2010	0.000688	25	0.0028%
2011	0.000748	25	0.0030%
2012	0.000576	25	0.0023%
2013	0.001375	25	0.0055%
2014	0.0004589	25	0.0018%
2015	0.001247	25	0.0050%
2016	0.001091	25	0.0044%
2017	0.000784	25	0.0031%
2018	<b>0.001947</b>	25	<b>0.0078%</b>
2019	0.0005892	25	0.0024%

**This table shows the total body dose to the public from the radioactivity in water discharged to the Hudson River. The doses are small fractions of the federal limit. Maximum amounts of each category shown in enlarged boldface type.**

**Releases of radioactively contaminated water to the Hudson River are monitored and controlled.**

**For example, R-19 is a radiation monitor in the Steam Generator Blowdown line to the discharge canal.**

### UNIT 3 LIQUID EFFLUENT SIMPLIFIED FLOW DIAGRAM

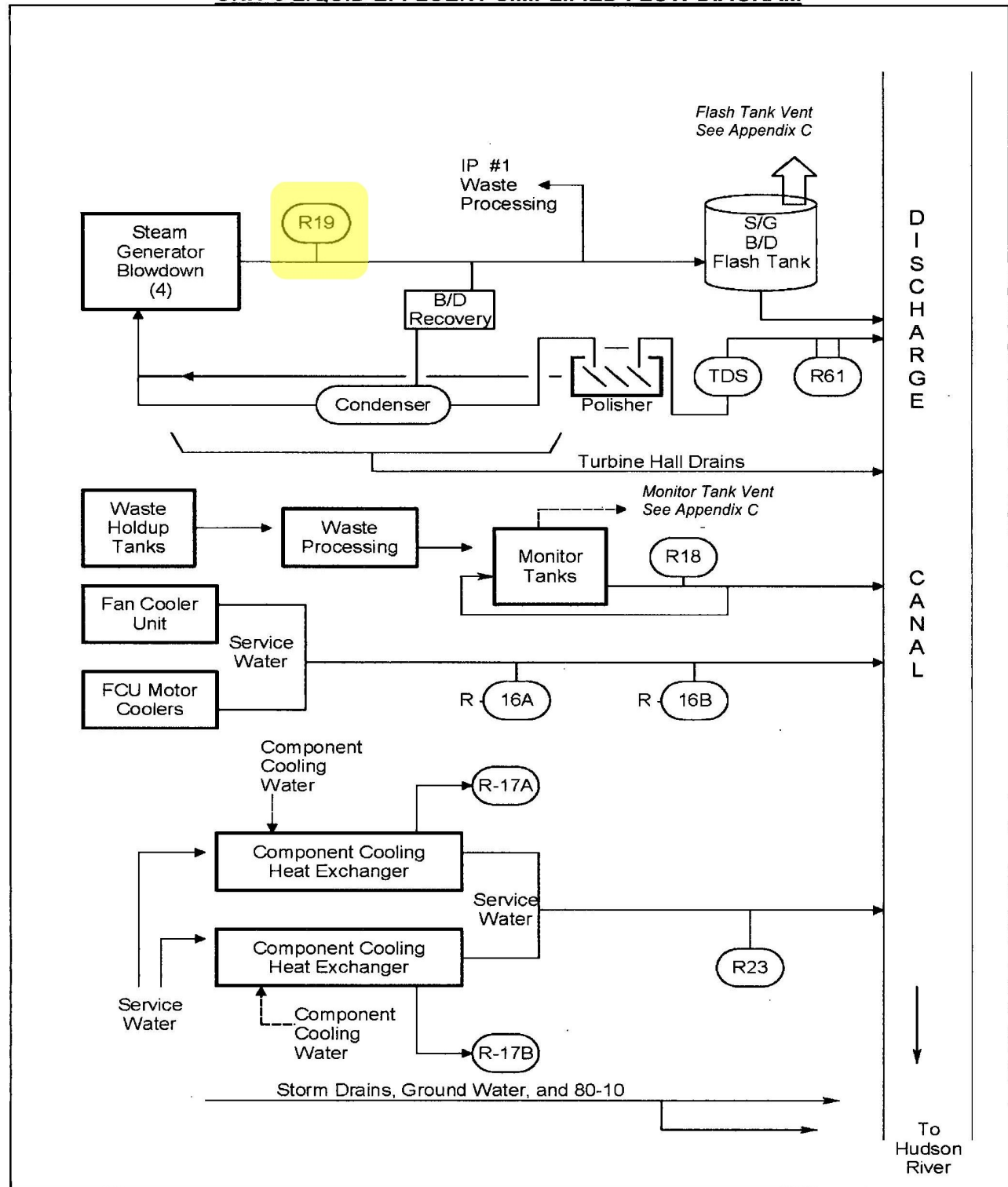


TABLE 1 – 2 Unit 3 Effluent Radiation Monitor System Data

CHANNEL	MONITOR DESCRIPTION	SAMPLING LOCATIONS	TYPICAL RANGE <sup>1</sup>	EFFLUENT CONTROL FUNCTIONS
R-12	Containment Gas Monitor	Samples drawn from 32 and 35 Containment Fan Coolers	9.2E-8 to 9.2E-2 $\mu\text{Ci/cc}$	Containment Ventilation Isolation
R-14	Plant Vent (PV) Radiogas Monitor	Installed within the plenum of the Plant Vent, 105' elevation	1.6E-7 to 1.6E-1 $\mu\text{Ci/cc}$	Secures waste gas tank release, isolates containment, aligns PV charcoal
R-15	Condenser Air Ejector Monitor	Adjacent-to-line detector, on the exhaust header, 53' Turbine Hall	2.8E-7 to 2.8E-1 $\mu\text{Ci/cc}$	On alarm, diverts air ejector exhaust to VC and secures steam to priming air ejectors re-heaters
R-20	Waste Gas Disposal System Monitor	Adjacent to line, on suction to waste gas compressors	1E-2 to 1E+3 $\mu\text{Ci/cc}$	None. This setpoint is based on limiting 50,000 Ci per tank, per RECS D3.2.6.
R-27	Plant Vent Wide-Range (Accident) Monitor	Drawn from inside Plant Vent to fan house near 80' airlock	Ch1-3) E-7 to E+5 $\mu\text{Ci/cc}$ Ch4) 10 to E+13 $\mu\text{Ci/sec}$	(Same functions as R-14)
R-46	Administration Building Vent Radiogas Monitor	4 <sup>th</sup> Floor Administration Building Monitor Exhaust Plenum for Controlled Areas	1E+1 to 1E+6 cpm (approx 5.0E-8 to 5.0E-2 $\mu\text{Ci/cc}$ )	None
R-59	RAMS Building Vent Radiogas Monitor	55' RAMS Building Monitor Exhaust Plenum	1E-6 to 1E+2 $\mu\text{Ci/cc}$	None
R-16 A/B	Fan Cooler and Motor Cooler Service Water Return	Adjacent to service water return line from V.C. fan cooler units and motor coolers	7.1E-7 to 7.1E-1 $\mu\text{Ci/ml}$	None
R-17 A/B	Component Cooling System pump outlet	Adjacent to line monitors on each pump outlet	2.3E-6 to 2.3E-1 $\mu\text{Ci/ml}$	None. These setpoints are based on early indication of RCS leak into CCW.
R-23	Component Cooling Heat Exchanger Service Water Monitor	Adjacent to line, mounted on SW return from Component Cooling Heat Exchanger	1.3E-6 to 1.3E-2 $\mu\text{Ci/ml}$	None
R-18	Waste Disposal Liquid Effluent Monitor	In-line monitor on monitor tank recirc pump discharge	4.0E-8 to 4.0E-2 $\mu\text{Ci/ml}$	Terminates monitor tank release on alarm
R-19	SG Blowdown Monitor	PAB blowdown room monitors steam generator blown	7.0E-8 to 8.2E+2 $\mu\text{Ci/ml}$ (using 2 ranges, per RG 1.97)	Closes blowdown isolation valves and SG sample valves
R-61	Condensate Polisher Facility (CPF) Regen Waste Release Monitor	Recirc line of HTDS/LTDS tanks in CPF (used during a primary to secondary leak).	1E-7 to 1E-1 $\mu\text{Ci/ml}$	Terminates HTDS or LTDS tank release. Applicable only in a primary to secondary leak, as defined in RECS D1.1.

<sup>1</sup> Actual Ranges of Rad Monitors (in Engineering Units) are a function of the selection of isotopes (average energy) and other factors.

**R-19 does more than passively monitor the radioactive content of the water flowing passed. If that level rises too high, it will trigger closure of valve to stop the release to the Hudson River.**

**Releases of radioactively contaminated water to the Hudson River are monitored and controlled.**

**For example, R-18 is a radiation monitor in the line from the waste tank to the discharge canal.**

# **UNIT 3 LIQUID EFFLUENT SIMPLIFIED FLOW DIAGRAM**

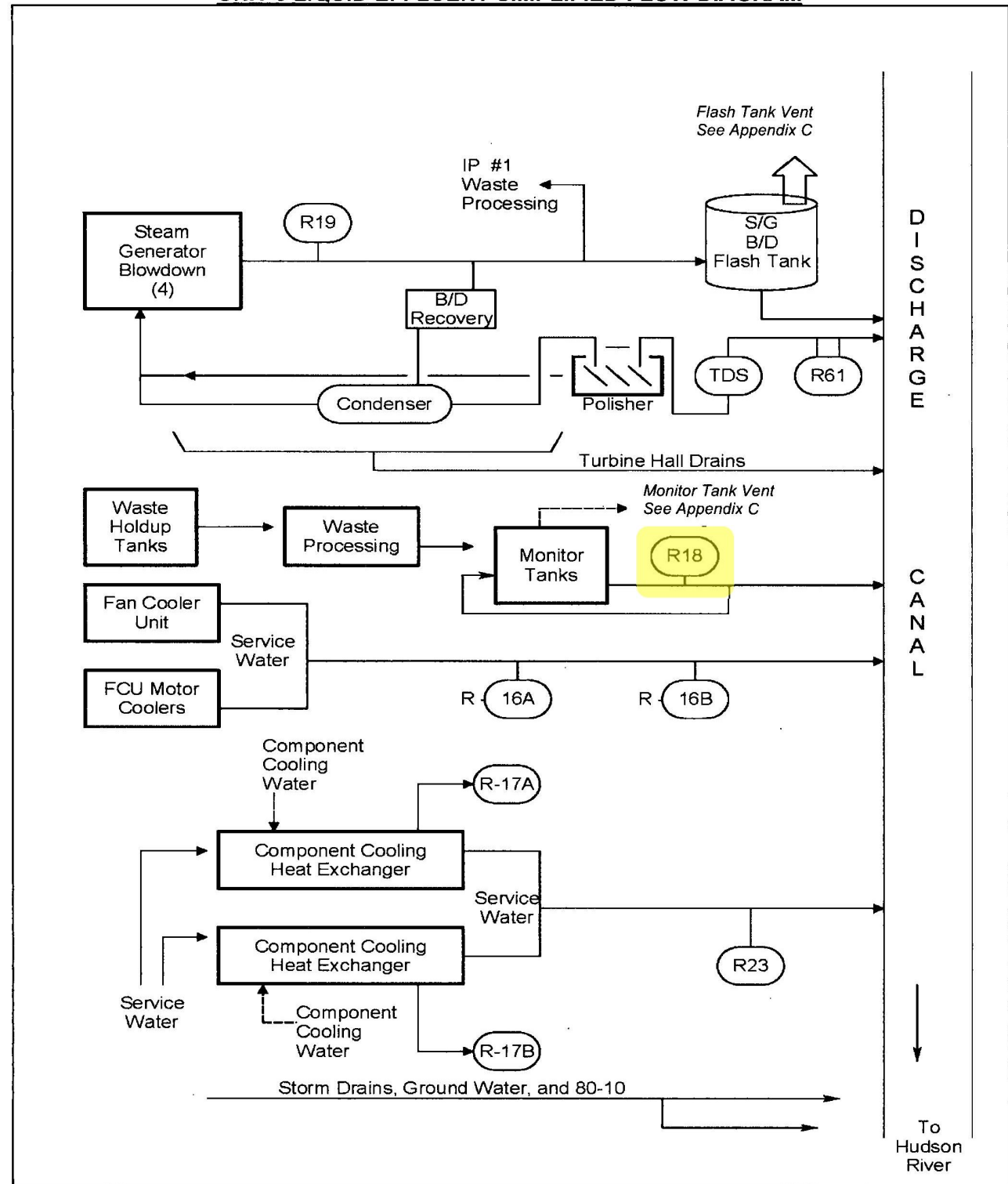


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R-15	Condenser Air Ejector Monitor	Adjacent-to-line detector, on the exhaust header, 53' Turbine Hall	2.8E-7 to 2.8E-1 $\mu\text{Ci/cc}$	On alarm, diverts air ejector exhaust to VC and secures steam to priming air ejectors re-heaters
R-20	Waste Gas Disposal System Monitor	Adjacent to line, on suction to waste gas compressors	1E-2 to 1E+3 $\mu\text{Ci/cc}$	None. This setpoint is based on limiting 50,000 Ci per tank, per RECS D3.2.6.
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<sup>1</sup> Actual Ranges of Rad Monitors (in Engineering Units) are a function of the selection of isotopes (average energy) and other factors.

**R-18 does more than passively monitor the radioactive content of the water flowing passed. If that level rises too high, it will trigger closure of valve to stop the release to the Hudson River.**

**Millions of gallons of radioactively contaminated water were released to the Hudson River each year.**

**The pathways were monitored and controlled to reduce the amount of radioactivity in the releases to ensure the radiation doses to the public from discharged liquids were below, far below, the federal limits.**